Management of Commissions to Meet the Regulatory Requirements: The Case of Property-Casualty Insurance in China

Kai Wang

wangkai@ahau.edu.cn

School of Science, Anhui Agricultural University, 130 Changjiangxi Road, Hefei 230036, China

Lei Fang

Lei.Fang@cass.city.ac.uk

Faculty of Actuarial Science and Insurance, Cass Business School, City, University of London, 106 Bunhill Row, London EC1Y 8TZ, U.K.

Jiang Cheng

jiangcheng@ln.edu.hk

Department of Finance and Insurance, Lingnan University, Hong Kong, China

Abstract

We investigate how the 2009 regulatory change to the method of calculating combined ratios in the Chinese property-casualty insurance industry affected the relationship between commissions and combined ratios. We find that since the 2009 reform, the industry has showed a non-linear relationship between commissions and combined ratios. The relationship is negative (positive) when the combined ratio is higher (lower) than the regulatory threshold. Before 2009, this relationship was linear. Since 2009, when commissions increase the combined ratios converges to the threshold. As the volatility of the combined ratio is positively related to the statutory capital required, this change provides incentives for insurers to decrease the combined ratio and/or its volatility, as they seek to manage their commissions to approximate the threshold without jeopardizing the compliance with other regulatory requirements.

Key words: New Enterprise Accounting Code, Chinese Property-Casualty Insurance Industry, Insurance Regulatory Requirements, Earnings Management, Combined Ratio, Commissions

JEL codes: G22, G32, G34

INTRODUCTION

We study how insurers manage their reported fees and commissions to agents (commissions hereafter) in response to the 2009 regulatory change in how the Chinese property-casualty (PC) insurance industry calculates the combined ratio. The enactments of the "New Enterprise Accounting Code" (NEAC) and the associated "New Indicator System Regulation for Statistics Analysis of Insurance Company" (NISR), which were directly applied to the insurance industry in 2009, have given plausibly exogenous shocks to the financial reporting of combined ratio. This set of changes provides an ideal setting to test how the regulatory change affects insurer incentives in the management of financial reporting.

The combined ratio is a key financial indicator for the performance of PC insurers, as this ratio reflects the insurers' underwriting results,[1] and it is one of the key indicators of an insurer's financial strength. This indicator is consistently monitored by the China Insurance Regulatory Commission (CIRC), which oversees the nation's insurance industry. According to the "Indicator of Insurance Companies' Solvency and Regulatory Requirements" , which was enacted in March 2003, PC insurance companies that had two consecutive years of average combined ratios higher than 103% were considered problematic. Since 2008, the CIRC has turned its regulatory emphasis to ensuring solvency, but the combined ratio is still being monitored. Loss ratio and expense ratio, which are the two components of the

[1] The combined ratio is the sum of the loss ratio and the expense ratio. The loss ratio is the sum of the total losses incurred and the associated adjustment expenses, divided by the premiums earned. The expense ratio is the percentage of the premium used to pay all of the costs of acquiring, writing, and servicing insurance and reinsurance, including the fees and commissions paid to agents, administration fees, and business taxes or surcharges. Both the loss and expense ratios are integral factors in the retrospective rating of basic premiums.

combined ratio, must be reported according to the "Property-casualty Insurance Companies' Quarterly Solvency Report Template." Furthermore, the ratio of actual capital to the minimum capital requirement (MCR) must be more than 200%. Otherwise, the deficiency will trigger regulatory interventions similar to those imposed in the risk-based capital system in the U.S. As the MCR is positively related to the volatility of the combined ratio, insurers have strong incentives to smooth their combined ratios over years, as a way to reduce the regulatory capital requirements.[2]

Commissions paid to agents constitute a significant portion of the costs for PC insurance companies in China. These commissions equaled 12% of total expenses in 2003, but soared to 29% in 2014 for the median insurers, and the increase had a direct impact on the insurers' profits and combined ratios. Among all of the regulatory indicators monitored by the CIRC, only the value of commissions appears in the calculation of the combined ratio. As is discussed in more detail in the next section, commissions can be managed to meet solvency sufficiency requirements and reduce the regulatory capital required through the combined ratio, and this kind of managing can be done without jeopardizing the compliance with other regulatory requirements. In this study, we focus on the effects of the NEAC and the associated NISR regarding insurance, since these regulations were applied in 2009. We consider the application of these reforms as an exogenous regulatory shock, which we can use to study the resulting changes in how insurers conduct strategic reporting on commissions.

[2] More specifically, one important factor in determining a firm's statutory capital is the volatility of the combined ratio. The more volatile the combined ratio is, the higher the statutory capital requirement is, according to Kremer (1982), Renshaw (1989), Verrall (1989), Zehnwirth (1989), and Yuan (2012). The detailed method of calculation is that a lognormal distribution is used to fit the historical data on the combined ratio, and then either the 95% or the 99% percentile is the factor used to calculate the minimum capital requirement.

Previous studies on earnings management in the PC insurance industry have mainly investigated how loss reserves are managed to avoid failures in meeting the regulators' requirements concerning solvency or premium rates.[3] To the best of our knowledge, however, commissions have received no attention in the earnings management literature, probably due to the difficulties involved in their manipulation, and their relatively smaller magnitude compared to the loss reserves in the U.S. PC insurance industry.

Arguably, loss reserves are easier to be managed than commissions, because loss reserves are based on the managers' subjective forecasts of future losses to be paid.[4] In contrast, commissions are the amounts paid to insurance agents and their intermediaries, from which the premiums are received. Therefore, commissions in the U.S. insurance industry are not a straightforward channel for managing earnings.

In China, the situation is quite different. Although it is rarely reported that commissions are managed in the U.S. insurance market, it is not uncommon in China. According to recent Chinese insurance intermediary market reports, insurance firms are frequently found to partner with agents to practice a kind of money laundering through the channel of commissions. Chen explains that "36 Insurance Regulatory Bureaus dispatched 43 teams to carry out inspections on 103 local business units of 20 insurers in 2011. ¥80.66 million earned by insurance companies were found to be illegal, which were made by faking or exaggerating commissions paid to intermediaries and agents. The opaque relationship between insurance companies and

[3] Petroni (1992); Petroni and Beasley (1996); Penalva (1998); Petroni et al. (2000); Gaver and Paterson (2004); Eckles et al. (2011); Grace and Leverty (2012); Gaver and Paterson (2012); Gaver and Paterson (2014).
[4] Petroni, et al. (2000); Beaver, et al. (2003); Grace and Leverty (2010); Grace and Leverty (2012).

intermediaries is considered a serious regulatory challenge in China's insurance market."[5]

Furthermore, commissions have always been among the top three largest items on the liability side of the financial statements issued by most Chinese PC insurers, even though commissions are normally smaller than loss reserves in terms of numerical values. Reserves for unearned premiums, loss reserves, and commissions always rank among the top three categories of insurers' liabilities. In 2003, the totals for these three categories were ¥43.18 million (for unearned premiums), ¥25.76 million(for loss reserves), and ¥2.55 million(for commissions), which accounted for 34%, 15%, and 3% of total liabilities, respectively.[6] A decade later in 2014, the largest three categories of liability were loss reserves (¥811.69 million), followed by reserves for unearned premiums (¥496.06 million), and then commissions (¥134.54 million). These categories accounted for 36%, 34%, and 10% of total liabilities, respectively.[7] The median and the mean of the ratios of commissions to income (i.e., the commission ratio) in 2014 were 11.2% and 11.7%, respectively. Although both loss reserves and commissions affect the final values of the combined ratio, it is the annual *difference* in the loss reserves (DLR) that is entered in the final calculation of the combined ratio. In that calculation, the DLR for year *t* is equal to the loss reserve for year *t*, minus the loss reserve for year *t*-1, minus the loss reserve recovered from

[5] Chen (2012, p. 25).

[6] In our earlier sample period, the lower value of the ratio of the loss reserves and premium unearned to total liabilities is due to the fact that China's insurance market is a newly developing market. In more recent period, these ratios in China are more comparable to those in U.S., e.g., loss reserves represented 38% of total liabilities and unearned premiums were 35%, for a total of 73% of total liabilities in 2014.

[7] The data used to calculate the combined ratio, including commissions, all come from the Income Statements. Only in the Introduction Section, data from the Balance Sheets are used to illustrate that the ratio of commissions to liability is very high, facilitating comparisons of the loss reserve to liability ratio which is frequently studied in literature.

reinsurance.[8] Taking 2008 as an example, we find that the median of DLR was ¥117.31 million, which was smaller than that of commissions. The medians of commissions and of loss reserves in China's PC industry (for 2008) were ¥146.91 and ¥462.59 million, respectively. These numbers were comparable with those of other years. Moreover, the median of premium income for 2008 was ¥1.33 billion, of which commissions accounted for 11%.[9] Thus, commission is the single most important factor in calculating the combined ratio in China.

More importantly, before the enforcement of the NEAC in 2009, there was a positive linear relationship between commissions and the combined ratios. As there is a regulatory threshold for the combined ratio (i.e., combined ratios larger than 1.03 are considered unhealthy by regulators), insurers are essentially constrained, and they have no incentives to manage commissions.

However, after the enactment of the NEAC in 2009, we find a non-linear relationship between the commissions and the combined ratios. More specifically, there is a critical value for the combined ratios (denoted by μ_t hereafter). Under reasonable assumptions, μ_t equals the regulatory threshold of 1.03. Commissions are positively related to the combined ratio when it is lower than μ_t. When the combined ratio is higher than the critical value μ_t, the relationship turns negative (i.e., the higher the commissions are, the lower the combined ratios will be).

[8] The annual *difference* in the loss reserves (DLR) in our paper is analogous to the item of *Loss reserve development one year* in Schedule P-Part 2-Summary Row 12 Column 11 of the U.S. PC NAIC Annual Statement. Ratio 11 of the IRIS system in U.S., the One-year Reserve Development to policyholders' surplus ratio, also uses One-year Reserve Development as the numerator of the ratio. Again, this "development" value enters in the calculation of CR in China as illustrated in Table 1 and is proved in proposition 4.

[9] The exchange rates in 2003, 2008 and 2014 are 8.2767, 6.8346 and 6.119, respectively, according to People's Bank of China.

Furthermore, the NEAC effectively increases the weight of commissions, which influences the combined ratio. As the volatility of the combined ratio is positively related to the statutory capital required, insurers can always increase commissions to move the combined ratio toward the critical value μ_t (i.e., meet the regulatory requirement and/or reduce the volatility of the combined ratio to reduce regulatory capital).

Although this study focuses on Chinese market, there are two reasons why the findings reported here offer insights for other countries. First, these changes of the accounting rules in China generally follow the West albeit with some minor adjustments, the denominator of the expense ratio (ER) is premiums earned (PE) instead of Premiums written (PW). However, it is the adjustments of an accounting item in the CR calculation that lead to the non-linear relationship between commissions and the combined ratio (CR). More specifically, contingent commissions presenting in both numerator and denominator of CR calculation lead to the non-linear relationship, distorting the implication of one of the most important regulatory ratio. We make a detailed analysis in Section 2 and Section 5. This may provide useful experience for the West when setting or adjusting the accounting rules: even a tiny change in the accounting rules might lead unexpected regulatory effects. Second, since 2016, China's insurance market has become the second largest one in the world, as measured by total premium income. We believe that China's market is attracting increasing interest worldwide. Many insurers have entered or plan to enter the Chinese market. These insurers are mostly from Western countries, and they are

also subject to regulations in their home countries. This internationalization of the insurance business requires the collaboration of insurance regulators from China and from Western countries. Such collaboration in turn calls for better understanding of the industry practices and regulations that are practiced in China. Therefore, this study should be of interest not only to industry participants and regulators in China, but also to those from Western countries.

The remainder of this study is organized as follows. Section 2 provides the theoretical analysis. The next section suggests the empirical expectations for predicting the behavior of PC insurance companies according to the theoretical analysis. Descriptive statistics are then presented, which show that our model is generally supported by strong empirical evidence. The next section shows the comparative analysis, which decomposes the different effects that the NEAC and the NISR have on the relationship between the commissions and the combined ratio. The last section offers our conclusions.

THEORETICAL ANALYSIS

In this section, we first conduct a theoretical analysis on the relationship between commissions, combined ratios, profits, and loss reserves. Then we determine the critical value at which the positive (negative) relationship between commissions and the combined ratios turns negative (positive).

Relationship Analysis

1. Commissions and Combined Ratios

The NEAC affects the combined ratio mainly through its changes to the method

for calculating unearned premium reserves (UPR) defined as portion of a policy's premiums that apply to the expired portion of the policy, which in turn causes changes in the calculation of premiums earned defined as portion of the policy premiums that have not yet been "earned" by the company because the policy still has some time to run before expiration. In the pre-NEAC era, UPR was calculated as a pre-determined (actuarially fair) proportion of premiums written. Correspondingly, the premiums earned were equal to the premiums written, minus the difference between the two adjacent years' UPR totals. However, the NEAC is more conservative in the way it calculates the UPR. More specifically, the UPR is calculated as a pre-determined proportion of the *adjusted* premiums written, from which the policy-acquiring expenses (including commissions, operating expenses related to writing policies, business tariffs and annexes, contributions to the Insurance Guarantee Fund, administration fees, and other miscellaneous expenses) have to be deducted first. The NEAC accounting formula thus effectively reduces the UPR, ceteris paribus. Since premiums earned are equal to premiums written minus UPR, commission is also involved in the calculation of premiums earned.

The second change to the industry caused by the NEAC involves the calculation of the expense ratio, which is a very important component of the combined ratio.[10] For the post-NEAC era, the denominator of the expense ratio changes from premiums written to premiums earned, thus the denominator of the combined ratio becomes

[10] During our sample period, the means (medians) for the loss ratio and the expense ratio are 0.54 (0.53) and 0.48 (0.42), respectively. The same values for the US P/C industry over that same period are 0.69 and 0.27 (source: iii.org), respectively. Note that the dramatic difference is largely due to the immature insurance market in the earlier sample period. Most insurers in China are spending significantly in marketing so as to maintain or acquire market share in fast-growing insurance market.

premiums earned. Because the calculation of the premiums earned involves the commissions, as a result, both the numerator and the denominator of the CR involve the commissions. These two changes alter the relationship between the commissions and the combined ratios. Table 1 provides a comparison of the methods used in calculating the combined ratio and the profit for insurers in the pre- and post-NEAC regimes.[11] We can see that both the numerator and the denominator involve the commissions when calculating the CR. Instead, in the pre-NEAC era, the commissions only appear in the numerator of the expense ratio, whose denominator is premium written, thus it does not involve the commissions.

According to Table 1, we derive the following proposition:

Proposition 1

(1) In the pre-NEAC era, commissions and the combined ratio were positively correlated.

(2) In the post-NEAC era, a threshold, μ_t, exists for the combined ratio. When the combined ratio is less than μ_t, the commissions and the combined ratio are positively correlated. When the combined ratio is larger than μ_t, the combined ratio is negatively correlated with commissions. Thus, when commissions increase, the combined ratio always approaches μ_t.

Detailed proof can be found in the Appendix.

[11] We use PW defined as the premiums registered on the books of an insurer or a reinsurer at the time a policy is issued and paid for for convenience here. We acknowledge that removal of these acquisition expenses affects both earned and unearned premiums. The NEAC procedures now require acquisition expenses to be removed from the unearned premium prior to being used in determining the earned premium amount (that would be used in determining the combined ratio). In the US market, acquisition expenses are removed from the net written premium amount prior to differentiation between earned and unearned premiums. Nevertheless, the results are not affected whether we use premiums written or net premiums written. The detailed proof is available upon request from the authors. We would like to thank an anonymous referee for pointing this out.

Proposition 1 implies that in the pre-NEAC era, the higher the commissions were, the higher the combined ratio was. However, in the post-NEAC era, the relationship between the two variables changes from a linear to a non-linear relationship (as shown in Figure 1a). When the combined ratio is less than the threshold μ_t, the higher the commissions are, the *higher* the combined ratio is. However, when the combined ratio is higher than the threshold μ_t, the higher the commissions are, the *lower* the combined ratio is. Most importantly, no matter whether the combined ratio is higher or lower than the threshold μ_t, the combined ratio always approaches μ_t with the increase in commissions.

Such a change in the relationship between commissions and the combined ratio incentivizes PC insurance companies to manage commissions. On one hand, those PC insurance companies with combined ratios higher than the critical value μ_t find that their combined ratios can be reduced and converged with μ_t by increasing their commissions. On the other hand, PC insurance companies with combined ratios lower than the critical value μ_t find that their combined ratios can be managed to converge with μ_t by increasing their commissions. In this way, the volatility of the combined ratios is decreased, as a means to decrease the minimum capital requirement.

2. Commissions and Expense Ratios

As commissions are an important part of the total expenses of PC insurance companies, we also analyze the relationship between commissions and the expense ratio.

Proposition 2

(1) In the pre-NEAC era, commissions and the expense ratio were positively correlated.

(2) In the post-NEAC era, a threshold μ_t exists for the expense ratio. When the expense ratio is less than μ_t, the commissions and expense ratios are positively correlated. When the expense ratio is larger than μ_t, it is negatively correlated with commissions. Thus, when commissions increase, the expense ratio always approaches μ_t.

Detailed proof can be found in the Appendix.

According to Proposition 2, the relationship between commissions and the expense ratio, and that between commissions and the combined ratio are exactly the same. In the pre-NEAC era, commissions and the expense ratios were positively correlated, but in the post-NEAC era, the two factors are non-linearly correlated. In other words, now there is a critical value, which is exactly the same as the critical value of the combined ratio μ_t. When the expense ratio is lower than the critical value μ_t, the commissions and expense ratios are positively correlated. However, when the expense ratio is larger than μ_t, the relationship turns negative. Moreover, no matter whether the expense ratio is higher or lower than μ_t, when commissions increase, the expense ratio converges to μ_t.

Therefore, the change in the relationship between commissions and expense ratios also incentivizes PC insurance companies to manage commissions. According to Propositions 1 and 2, now there are two incentives for managing commissions:

either to manage the combined ratio, or to manage part of the combined ratio, i.e., the expense ratio.

3. Commissions and Profits

Commissions also influence profits, because commissions are one of main expenses for PC insurance companies. We therefore study the sensitivity of profits to commissions.

Proposition 3

In both the pre- and post-NEAC era, commissions and profits are negatively and linearly correlated. In the post-NEAC era, the sensitivity of profits to commissions is less than it was in the pre-NEAC regime.

Detailed proof can be found in the Appendix.

Thus, commissions and profits are always negatively correlated. In the post-NEAC era, however, profit is less sensitive to commissions, as the new regulations facilitate insurers' management of combined ratios by using commissions.

4. Loss Reserves and Combined Ratios

For the sake of comparison, we carry out similar theoretical analysis on the relationship between loss reserves and combined ratios.

Proposition 4

In both the pre- and post-NEAC era, loss reserves and combined ratios are positively and linearly correlated.

Detailed proof can be found in Appendix.

The relationship between loss reserves and combined ratios is the same in both

the pre- and post-NEAC era. However, the degree of sensitivity between these factors is reduced in the post-NEAC era. Therefore, it is harder to manage combined ratios through manipulating loss reserves in the post-NEAC era.

The Critical Value

According to Propositions 1 and 2, in the post-NEAC era, the critical value μ_t is crucial in determining the non-linear relationship between commissions and the combined ratio, or the expense ratio. Also, the size of μ_t determines the behavior of the PC insurance companies. If the value of μ_t is too large (i.e., much higher than the regulatory threshold of 1.03), then it makes no sense to reduce the combined ratio or the expense ratio to converge with μ_t by increasing commissions. However, if the value of μ_t is too small, PC insurance companies have to make large increase in the scale of commissions to meet the goal of converging to μ_t, which is difficult to implement in practice.

However, according to Proposition 1, the critical value μ_t contains the function of the commissions of two adjacent years during the post-NEAC era, as shown in the proof below. Obviously, it is impossible to obtain the expression for the function of the commissions from two adjacent years, and it is only possible to prove the existence of the threshold μ_t. We cannot determine the exact, actual numerical value either, which impedes the prediction of potential behavior by PC insurance companies and prevents further empirical analysis. To estimate the critical value μ_t and facilitate empirical analysis, we introduce the variables of *adjusted premium earned* and *adjusted combined ratio*. The *adjusted premiums earned* refers to the original

formula of premiums earned minus the term of the UPR in year *t*-1. That is, *adjusted premiums earned* is equal to the net premiums written in year t, minus the UPR in year *t*. Accordingly, the combined ratio that is calculated by using the adjusted premiums earned is called the *adjusted combined ratio* (shown in Table 1).

Proposition 5

The adjusted combined ratio has the same properties as the combined ratio in Proposition 1, and its threshold of $\frac{1}{\theta_t}$ corresponds to μ_t.

Detailed proof can be found in the Appendix.

Proposition 5 indicates that in the pre-NEAC era, the adjusted combined ratios and the commissions were positively correlated, but in the post-NEAC era the relationship turns into non-linear (as shown in Figure 1b). This relationship is perfectly consistent with that between commissions and the combined ratio, and the threshold of the adjusted combined ratio $\frac{1}{\theta_t}$ corresponds to that of the combined ratio μ_t, with both factors being time variant. It is worth noting that θ_t is the proportion used to calculate the UPR out of the premiums, i.e., $UPR_t = PW_t \cdot \theta_t$. We use the adjusted combined ratio instead of the combined ratio to empirically analyze these relationships with commissions, because the threshold $\frac{1}{\theta_t}$ is estimable. However, it is impossible to determine the exact data on μ_t and θ_t for all years. For convenience, we set $\frac{1}{\theta_t} = 2$ for all years and all companies. Under realistic assumptions regarding the growth rate of premiums, $\mu_t = 1.03$ correspondingly.

Such an approximation is realistic for three reasons. (1) In practice, θ_t is usually denoted as 1/2 under the straight-line method. (2) Our data sample validates the choice of 1/2.[12] (3) In the further empirical analysis to follow, we will include the robustness tests, with $\frac{1}{\theta_t}$ being altered from 1.8 to 2.2.

Proposition 6

Under a certain premium growth ratio, when the threshold of the adjusted combined ratio $\frac{1}{\theta_t} = 2$, the threshold of the combined ratio $\mu_t = 1.03$. The figure of 1.03 is therefore exactly the regulatory threshold of the CIRC.

Detailed proof can be found in the Appendix.

According to Propositions 1, 5, and 6, the adjusted combined ratio and the combined ratio have a one-to-one correspondence, and the threshold of the adjusted combined ratio corresponds to the regulatory upper bound set by the CIRC.

The altered relationship between the combined ratios and commissions in the post-NEAC era provides insurers with incentives to manage commissions, although this outcome might be unexpected by regulators. On one hand, PC insurance companies with combined ratios higher than the critical value μ_t may reduce their combined ratios, as they seek to meet the regulatory requirement by increasing commissions. On the other hand, insurers with combined ratios lower than the critical value μ_t may increase the combined ratio by increasing commissions, thereby

[12] In 2003 to 2014, the means of θ_t were 0.44, 0.50, 0.47, 0.52, 0.61, 0.55, 0.51, 0.47, 0.49, 0.47, 0.49, and 0.48, respectively. The values of θ_t after 2009 are estimations, because we cannot obtain the exact data of the initial expense after 2009.

reducing the volatility of the combined ratios across different years, and reducing the regulatory capital associated with the minimum solvency requirement.[13]

Similarly, according to Propositions 2 and 6, with the increase in commissions, the expense ratio always converges to the critical value μ_t. Considering that $\mu_t = 1.03$, and that the expense ratio is generally only half of the combined ratio, we note that if the expense ratio is managed to converge to μ_t, then the combined ratio must be much higher than the regulatory standards. As a result, it is very unlikely for PC insurance companies to manage the expense ratio by managing commissions, because managing the expense ratio to μ_t makes no sense.

We have already proven that in the post-NEAC era, the critical value for the adjusted combined ratio is $\frac{1}{\theta_t}$. Here, we further calculate its corresponding critical value in the pre-NEAC era.

Proposition 7

If the critical value for the adjusted combined ratio in the post-NEAC era is $\frac{1}{\theta_t}$, then the corresponding critical value in the pre-NEAC era is $\frac{1}{\theta_t} + \frac{\alpha_t}{1-\theta_t}$, where α_t is defined as the proportion of initial expenses in the premium income, and this variable is time variant.

Detailed proof can be found in the Appendix.

[13] Insurers implicitly have two goals in mind when managing commissions to affect combined ratios in our settings. The first objective is to meet the regulatory requirement of combined ratio so as to avoid regulatory actions. The second objective is to reduce the regulatory capital. These two goals are not conflicting with each other. We would like to thank an anonymous referee for bringing these two goals to our attention.

EMPIRICAL IMPLICATIONS

According to the theoretical analysis given above, the implementation of the NEAC and NISR changed the relationship between commissions and the combined ratios, which incentivized PC insurance companies to reduce the combined ratios and/or its volatility by managing commissions. Meanwhile, changes in commissions also affected profits. Therefore, we categorize PC insurance companies into four states, according to their levels of profits and their combined ratios, and we predict these firms' likely behaviors following the 2009 regulatory changes (Table 2).

For the situation following the enactment of the NEAC, we define profitable insurers that are limited by an upper bound μ_t as being in State 1. Companies in this state also have regulatory constraints under certain circumstances. We predict that being in State 1 guarantees that increasing the commissions does not cause the combined ratio to exceed the regulatory requirement. Insurers in State 1 thus have incentives to increase the combined ratio toward the upper bound μ_t, as a way to decrease the volatility of the combined ratio over years and to decrease the minimum capital requirement, so long as they meet their profit targets.

In contrast, profitable insurers in State 2 want to keep the combined ratio below the regulatory threshold to avoid regulatory intervention. A negative relationship between commissions and the combined ratio occurs when the combined ratio is higher than the critical value μ_t, and therefore State 2 insurers have strong incentives to increase commissions.

Insurers in State 3 are facing losses, and we postulate that in the post-NEAC era

these insurers have no incentives to increase commissions, because any increase in commissions aggravates their losses, and they have already met the regulatory requirement on the combined ratio.

In contrast, insurers with losses in State 4 have strong incentives to increase their commissions, as a means to decrease their combined ratios to below the regulatory threshold. Admittedly, the increase in commissions exacerbates losses. However, in the post-NEAC era, the sensitivity of profit to commissions is less than it was in the pre-NEAC era. These conditions enhance the managers' incentives to avoid regulatory intervention at the (reduced) cost of exacerbating loss reporting.

All in all, in the post-NEAC era, PC insurance companies in States 1, 2, and 4 are likely to decrease their combined ratios and/or its volatility by increasing commissions, either to meet the regulatory standards or to decrease their minimum capital requirements. However, insurers in State 3 lack the incentive to manage commissions, because they have already met the regulatory standards and are already operating at a loss.[14]

According to Proposition 4, there is no change in the relationship between loss reserves and the combined ratios, which are positively correlated in both the pre- and post-NEAC eras. Moreover, in the post-NEAC era, the sensitivity of the combined

[14] Increased commissions will lead to lower profits, but this will not have a significant impact on attracting investors. First, a high level of commissions might signal that insurance companies are increasing their market shares through aggressive marketing strategies. This is particular important to potential investors in current Chinese insurance market. Second, according to Proposition 3, in the post-NEAC era, profit is less sensitive to the changes in commissions, i.e. the decrease in profit due to the increase in commissions is smaller in magnitude. Finally, major investors of insurers in China are government agencies and large institutional investors. They are financially sophisticated and can arguably look through the vein of commission management. If commission management can reduce regulatory costs, mature investors will not care about short-term reported underwriting performance. It is plausible that an insurer is more concerned about reducing real regulatory costs than "reported" underwriting performance to attract investors.

ratio to loss reserves is lower. As a result, PC insurance companies lack the incentive to manage their combined ratios by managing loss reserves.

It is worth noting that commission management might have also existed before 2009. However, we argue that commissions are clearly managed more after 2009 than they were in the pre-2009 era, and such management is likely to be the direct result of a pseudo-exogenous shock, i.e., the enactment of the NEAC and the NISR.

DESCRIPTIVE STATISTICS

Data on the commissions of PC insurance companies during the 2003–2014 period are used to validate our predictions on company behavior. We start to collect data from 2003 because the ISRS ("Indicator System Regulation for Statistics Analysis of Insurance Company"), which was the last change in the regulatory system before the NEAC, occurred in 2003. The insurance companies chosen for our sample have been in constant operation for at least two years, and have had non-negative earned premiums. Policy-based agriculture insurance companies are excluded, so the final sample includes 55 companies. We drop abnormal values of the adjusted combined ratio in both the upper and lower 1% for 2003–2008 and 2009–2014 respectively.[15,16] This leaves us with 357 firm-year observations, among which 107 happened before the NEAC was enacted.

We classify companies into four states according to their profits and their

[15] Beaver, et al. (2003).

[16] Note that PC insurance companies have formally adopted the NEAC and the associated NISR since 2009. The NEAC was issued in 2006 by the Chinese Ministry of Finance, with the Accounting Standards Interpretation (ASI) No. 2 being issued in August 2008. However, it was not until Jan. 1, 2009 that "The Implementation of ASI No. 2 to the Insurance Industry" was issued, which required all insurance companies operating in China to follow the new accounting policies. In the same year, NISR (JR/T0047-2009) was issued and enforced by the Insurance Technical Committee of National Committee on the Standardization of Finance.

combined ratios. More specifically, in following Propositions 1 and 4, we adopt the adjusted combined ratio as determined according to the critical value $\frac{1}{\theta_t}$, rather than the combined ratio as used in our state classifications. Correspondingly, according to Proposition 7, the critical value of the adjusted combined ratio in the pre-NEAC era was $\frac{1}{\theta_t}+\frac{\alpha_t}{1-\theta_t}$.

We first analyze the descriptive statistics of the overall trend in the commission ratio and the loss reserve ratio. We define the commission ratio as commissions divided by premiums written, and we present the descriptive statistics in Panel A of Table 3. The mean of the commission ratio has increased in the post-NEAC era (mean is0.1000) compared to the pre-NEAC era (mean is 0.0677). Statistical tests confirm that the mean of the commission ratio has increased in the post-NEAC era, significantly at the 1 percent level (t-statistics is -7.1266).

Panel B of Table 3 presents the descriptive statistics on the loss reserve ratio, with the definition of this term being the DLR divided by net premiums income. We do not observe significant differences between the 2003–2008 and 2009–2014 regimes(t-statistics is 0.1738).

According to the Panel C of Table 3, the volatility of the adjusted combined ratio has decreased in the post-NEAC era (standard deviation is 0.7640) compared to the pre-NEAC era (standard deviation is 5.3065). Statistical tests confirm that the volatility of the adjusted combined ratio has decreased in the post-NEAC era, significantly at the 1 percent level (F-statistics is 48.2395). We also find that the

coefficients of variation and skewness of the adjusted combined ratio in 2009-2014 are significantly smaller than those in 2003-2008, implying adjusted combined ratios are less right skewed and more clustered. One potential reason is that the increasing commissions of ***all*** insurers after the NEAC leads to the relatively reduced adjusted combined ratio and its volatility.

Then we analyze the trend of the commission ratios and the loss reserve ratios of PC insurance companies in different states. Figure 2a shows the trend in the medians of commission ratios of PC insurance companies in different states. We assume that $\frac{1}{\theta_t} = 2$, and $\alpha_t = 20\%$. The numbers of firm-year observations in each of the four states are 183, 51, 42, and 81, respectively. Between 2003 and 2008, 64, 22, 20, and 27 observations were in states 1 to 4, respectively. The corresponding numbers changed to 119, 29, 22, and 54 in the years between 2009 and 2014, respectively.[17] Obviously, there were major changes around 2009 for firms in States 1, 2, and 4, and especially for those in State 1. However, commission ratios remained relatively stable after 2009, and the numbers of insurers in State 3 did not show an upward jump in 2009.

Figure 2b shows the trends of median loss reserve ratios for insurers in the four states. We do not observe jumps in these ratios around 2009, or in other years.

From the above-given analysis, we can see that PC insurance companies generally show an increase in their commission ratios in the post-NEAC era, but the loss reserve ratio does not change significantly. More specifically, in the post-NEAC

[17] The total numbers of insurers in the four states are 41, 20, 25, 29, respectively, with 21, 12, 13, 15 in 2003–2008, and 34, 15, 15, 23 in 2009–2014, respectively.

era, companies in States 1, 2, and 4 experience obvious jumps in 2009, but this does not happen for companies in State 3. Similarly, the loss reserve ratios do not change significantly for companies in any of the four states. This set of findings implies that in the post-NEAC era, PC insurance companies decrease their combined ratios and/or its volatility by increasing their commissions.

COMPARATIVE ANALYSIS

According to the above-described analysis, we find that PC insurance companies are able to reduce their combined ratios and/or its volatility by increasing commissions in the post-NEAC era. It is noticeable that this behavior is facilitated by the enactment of two different supervisory regulations, namely the NEAC ("New Enterprise Accounting Code") and the associated NISR ("New Indicator System Regulation for Statistics Analysis of Insurance Company"). In this section, we show how the NEAC and the NISR play different roles in changing the behavior of PC insurance companies.

If Only the NEAC Was Enforced, But Not the NISR

If only the NEAC was enforced, but the NISR was not, then the UPR (unearned premium reserve) would have been accrued according to NEAC. However, the expense ratio, which is part of the combined ratio, would be calculated according to the previous formula (i.e., the denominator of the expense ratio would remain the premiums written (PW) rather than the premiums earned (PE)). Based on this scenario, we offer Proposition 8 as follows.

Proposition 8

If the NISR was not enacted, then during the pre-NEAC era the commissions and the combined ratios would have been linearly and positively correlated. However, in the post-NEAC era the commissions and the combined ratio would be non-linearly correlated.

Detailed proof can be found in the Appendix.

Actually, it can be found in the proof of Proposition 8 that if the NISR was not applied, the loss ratio would be the root of the non-linear relationship in the post-NEAC era. In other words, since the enactment of NEAC, changes in commissions affect not only the expense ratios, but also the loss ratios, and therefore changes in commissions affect the combined ratios in a non-linear way.

If Only the NISR was Enforced, but not the NEAC

If only the NISR was enforced, but the NEAC was not, then the denominator of the expense ratio would be PE, but the UPR would be accrued according to the previous accounting code. With this in mind, we make Proposition 9.

Proposition 9

If the NEAC was never enforced (in either the pre- or the post-NISR era), then the commissions and the combined ratios would be linearly and positively correlated. However, in the post-NISR era, the combined ratio would be more sensitive to commissions.

Detailed proof can be found in the Appendix.

According to Propositions 8 and 9, the key reason for the changes in the

relationships between the commissions and the combined ratios is the enforcement of the NEAC. It is the enforcement of NEAC that causes the non-linear relationship between commissions and the combined ratios, which incentivizes PC insurance companies to manage commissions. Meanwhile, according to Proposition 2, the NEAC reduces the sensitivity of profits to commissions, which further facilitates PC insurance companies in managing commissions without worrying about the impact on profits. Although the enforcement of the NISR does not essentially change the relationship between commissions and the combined ratios, it increases the sensitivity of the combined ratios to commissions, which provides further incentive and freedom for PC insurance companies to manage commissions.

CONCLUSIONS

The enactment of the NEAC and the NISR changed the relationship between commissions and the combined ratios of PC insurance companies, turning this relationship from being linear and positive to non-linear. More specifically, in the post-NEAC era, if the combined ratio is lower than the critical value μ_t, then the commissions and the combined ratios are still positively correlated; however, if the combined ratio is higher than the critical value μ_t, then they are negatively correlated. Moreover, no matter whether the combined ratio is higher or lower than the critical value μ_t, when the commissions increase, the combined ratios always converge to the critical value μ_t.

We further find that under certain realistic assumptions, the critical value μ_t is equal to the regulatory threshold (1.03). This pattern implies that such a non-linear

relationship incentivizes PC insurance companies to manage commissions. PC insurance companies are able to reduce their combined ratios as long as those ratios are larger than the critical value μ_t, no matter whether they are profitable or operating at a loss. Those profitable companies that have combined ratios lower than μ_t are able to decrease the volatility of their combined ratios by increasing commissions, and thereby reduce the minimum capital requirement. Companies that experience losses and have combined ratios lower than μ_t have already met the regulatory requirement, and thus they lack the incentive to manage commissions.

Based on our comparative analysis, both the NEAC and the NISR contribute to the observed changes. The NEAC mainly turns the positive linear relationship between commissions and combined ratios into a non-linear relationship, and it reduces the sensitivity of commissions to profits. The NISR serves to increase the sensitivity of combined ratios to commissions. Both the NEAC and the NISR incentivize and facilitate the management of commissions by PC insurance companies.

However, neither the NEAC nor the NISR change the relationship between loss reserves and combined ratios, which is always positive. Furthermore, in the post-NEAC era the sensitivity of combined ratios to loss reserves is reduced, thereby reducing the incentive to manage the combined ratios by managing loss reserves. This second pattern is also supported by our data.

REFERENCES

Beaver, W. H., M. F. Mcnichols, and K. K. Nelson (2003), "Management of the Loss Reserve Accrual and the Distribution of Earnings in the Property-Casualty Insurance Industry," *Journal of Accounting and Economics*, Vol. 35, No. 3, pp. 347-376.

Chen, W. H. (2012), *Report of Chinese Insurance Intermediary Market*, China Financial and Economic Publishing House, Beijing, China.

Eckles, D. L., M. Halek, E., He, D. W. Sommer, and Zhang, R. (2011), "Earnings Smoothing Executive Compensation and Corporate Governance," *Journal of Risk and Insurance*, Vol. 78, No. 3, pp. 761-790.

Gaver, J. J. and J. S. Paterson (2004), "Do Insurers Manipulate Loss Reserves to Mask Solvency Problems?," *Journal of Accounting and Economics*, Vol. 37, No. 3, pp. 393-416.

Gaver, J. J. and J. S. Paterson (2014), "The Association between Actuarial Services and Audit Quality," *Auditing: A Journal of Practice and Theory*, Vol. 33, No. 1, pp. 139-159.

Gaver, J. J., J. S. Paterson, and C. J. Pacini (2012), "The Influence of Auditor State-level Legal Liability on Conservative Financial Reporting in the P-C Insurance Industry," *Auditing: A Journal of Practice and Theory*, Vol. 31, No. 3, pp. 95-124.

Grace, M. F. and J. T. Leverty (2010), "Political Cost Incentives for Managing the Property Liability Insurer Loss Reserve," *Journal of Accounting Research*, Vol. 48, No. 1, pp. 21-49.

Grace M. F. and J. T. Leverty (2012), "Property–liability Insurer Reserve Error: Motive, Manipulation, or Mistake," *Journal of Risk and Insurance*, Vol. 79, No. 2, pp. 351-380.

Kremer, E. (1982), "IBNR Claims and the Two Way Model of ANOVA," *Scandinavian Actuarial Journal*, Vol. 1982, No. 1, pp. 47-55.

Penalva, F. (1998), "Loss Reserves and Accounting Discretion in the Property-Casualty Insurance Industry," Ph.D. Dissertation, Accounting, University of California, Berkeley.

Petroni, K. R. (1992), "Optimistic Reporting in the Property-Casualty Insurance Industry," *Journal of Accounting and Economics*, Vol. 15, No. 4, pp. 485-508.

Petroni, K. R. and M. Beasley (1996), "Errors in Accounting Estimates and Their Relation to Audit Firm Type," *Journal of Accounting Research*, Vol. 34, No. 1, pp. 151-171.

Petroni, K. R., S. G. Ryan, and J. R. Wahlen (2000), "Discretionary and Non-Discretionary Revisions of Loss Reserves by Property-Casualty Insurers: Differential Implications for Future Profitability, Risk and Market Value," *Review of Accounting Studies*, Vol. 5, No. 2, pp. 95-125.

Renshaw, A. E. (1989), "Chain-ladder and Interactive Modelling (Claims Reserving and GLIM)," *Journal of the Institute of Actuaries*, Vol. 116, No. 3, pp. 559-587.

Verrall, R. J. (1989). "A State Space Representation of the Chain-ladder Linear Model," *Journal of the Institute of Actuaries*, Vol. 116, No. 3, pp. 589-610.

Yuan, Z. (2012), "The Empirical Study of the Minimum Capital Standard of China's Properties-Casualty Companies," *Insurance Studies*, Vol. 2012, No. 3, pp. 39-44.

Zehnwirth, B. (1989), "The Chain-ladder Technique of a Stochastic Model," *Claims Reserving Manual*, Vol. 1989, No. 2, pp. 2-9.

Figure 1. Relationship between Commissions and Combined Ratios/Adjusted Combined Ratios

Figure 1 includes Figures 1a and 1b. In Figure 1a, the relationship between Commissions (horizontal axis) and Combined Ratio (vertical axis) is nonlinear, and obviously there is a limit μ_t. When the Combined Ratio is lower than the critical value μ_t, the Commissions and the Combined Ratios are still positively correlated, but when the Combined Ratio is higher than the critical value μ_t, the relationship turns to a negative correlation, i.e., the higher the Commissions, the lower the Combined Ratios.

Figure 1b shows the relationship between Commissions and Adjusted Combined Ratios. The horizontal axis is Commissions, and the vertical axis is Adjusted Combined Ratios. The relationship between these factors is also nonlinear, and there is a limit at $1/\theta_t$. When the Adjusted Combined Ratio is lower than the critical value $1/\theta_t$, the Commissions and the Adjusted Combined Ratios are still positively correlated, but when the Adjusted Combined Ratio is higher than the critical value of $1/\theta_t$, the relationship turns to a negative correlation, i.e., the higher the Commissions are, the lower the Adjusted Combined Ratios are.

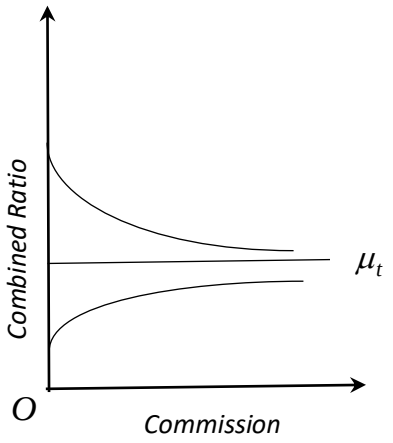

Figure 1a. Relationship between Commissions and Combined Ratios

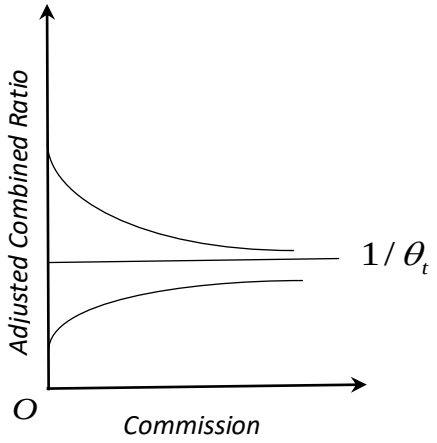

Figure 1b. Relationship between Commissions and Adjusted Combined Ratios

Figure 2. Trend of the Commission Ratio/Loss Reserve Ratio Relationship

Figure 2 includes Figures 2a and 2b. Figure 2a shows the trend of the Commission Ratio, with the horizontal axis being the year, and the vertical axis being the medians of the Commission Ratios of PC insurance companies. Figure 2b shows the trend of the Loss Reserve Ratio, in which the horizontal axis has the same meaning, and the vertical axis represents the medians of the Loss Reserve Ratios. The States are classified by Profit and by Adjusted Combined Ratio. From 2009 to 2014, when Profit is positive and the Adjusted Combined Ratio is lower or higher than the critical value $1/\theta_t$, the company is in State 1 or State 2. When Profit is negative and the Adjusted Combined Ratio is lower or higher than the critical value $1/\theta_t$, the company is in State 3 or State 4. From 2003 to 2008, the critical value of the Adjusted Combined Ratio is replaced by $\frac{1}{\theta_t}+\frac{\alpha_t}{1-\theta_t}$. The θ_t is the unearned proportion of year *t*, which is calculated by using the Proportion Approach or the Risk Distribution Approach. The variable α_t is the proportion of initial expenses in the premium income. Here, $1/\theta_t = 2$, $\alpha_t = 20\%$, and *—, ○—, ☆—, △— represent companies in States 1, 2, 3, and 4, respectively.

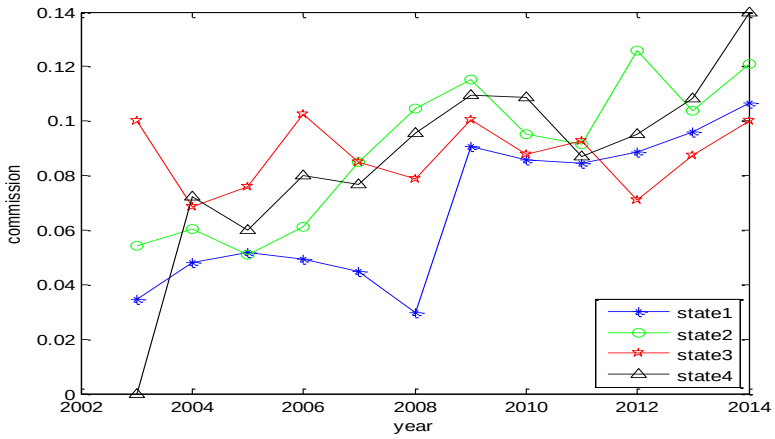

Figure 2a. Trend of Commission Ratios

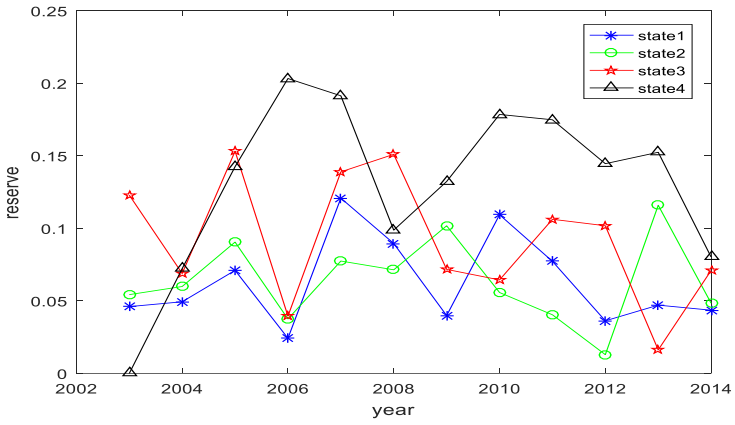

Figure 2b. Trend of Loss Reserve Ratios

Table 1. Formulae for the Combined Ratio and Other Indicators

Table 1 includes formulae for both the pre- and post-NEAC eras, including premiums earned, Combined Ratios, profits, adjusted premiums earned, Adjusted Combined Ratios, and other variables. In the table, UPR_t is the Unearned Premium Reserve of year *t*. PE_t is the premium earned in year *t*. CR_t is the Combined Ratio for year *t*. APE_t is the adjusted premium earned in year *t*. ACR_t is the Adjusted Combined Ratio for year *t*. $Profit_t$ is the profit for year *t*, PW_t is the premiums written in year *t*. θ_t is the unearned proportion of year *t*, calculated by using the Proportion Approach or the Risk Distribution Approach, and with $\theta_t \in [0,1]$. Fc_t is the commissions for year *t*. E_t is the initial expenses for year *t*, excluding commissions (but including fees related to setting up policies, business taxes and surcharges, global reserves, or supervisory expenses). RM_t is the reserves for unearned premiums (or risk margins) in year *t*, which are usually equal to 0. PC_t is Net Paid Claims for year *t*. DLR_t is difference in the loss reserve for year *t*. E'_t is all expenses, excluding initial expenses (mainly including administration and reinsurance expenses). $C_t = PC_t + DLR_t + Fc_t + E_t + E'_t$, i.e., total claim payments and expenses.

	$pre-NEAC$	$post-NEAC$
UPR_t	$PW_t \cdot \theta_t$	$\left[PW_t - \left(Fc_t + E_t\right)\right] \cdot \theta_t + RM_t$
PE_t	$PW_t - \left(UPR_t - UPR_{t-1}\right)$	$PW_t - \left(UPR_t - UPR_{t-1}\right)$
CR_t	$\frac{PC_t + DLR_t}{PE_t} + \frac{Fc_t + E_t + E'_t}{PW_t}$	$\frac{PC_t + DLR_t + Fc_t + E_t + E'}{PE_t}$
APE_t	$\left(1-\theta_t\right)PW_t$	$\left(1-\theta_t\right)PW_t + \left(Fc_t + E_t\right)\theta_t - RM_t$
ACR_t	$\frac{PC_t + DLR_t}{APE_t} + \frac{Fc_t + E_t + E'_t}{PW_t}$	$\frac{PC_t + DLR_t + Fc_t + E_t + E'}{APE_t}$
$Profit_t$	$PE_t - C_t$	$PE_t - C_t$

Table 2. States of PC Insurance Companies

Table 2 shows the classification of PC insurance companies. We divide these companies into four states, according to two dimensions: profit (higher or lower than 0), and CR (the Combined Ratio higher or lower than the critical value μ).

	$CR \leq \mu$	$CR > \mu$
$Profit > 0$	S_1 : State 1	S_2 : State 2
$Profit \leq 0$	S_3 : State 3	S_4 : State 4

Table 3. Descriptive Statistics from 2003 to 2014

Panels A, B and C show the descriptive statistics for the Commission Ratios, the Loss Reserve Ratios and the adjusted combined ratio, respectively, from 2003 to 2014. The numbers of samples, the means, standard deviations, medians, coefficients of variation (CV), skewness, and maximums and minimums of these variables are included in the table.

Panel A：Descriptive Statistics of Commission Ratios								
	Company	Mean	Standard Deviation	Median	CV	Skew	Max	Min
2003	20	0.0477	0.0448	0.0456	0.9380	0.7644	0.1590	0.0000
2004	21	0.0532	0.0318	0.0580	0.5990	0.5681	0.1374	0.0063
2005	24	0.0578	0.0375	0.0611	0.6489	1.0541	0.1744	0.0087
2006	20	0.0690	0.0411	0.0670	0.5950	0.3688	0.1689	0.0086
2007	22	0.0805	0.0391	0.0780	0.4856	0.4016	0.1744	0.0176
2008	26	0.0924	0.0467	0.0897	0.5049	0.9866	0.2423	0.0096
2009	30	0.1019	0.0421	0.1006	0.4134	1.2788	0.2579	0.0165
2010	31	0.0894	0.0355	0.0893	0.3974	0.5585	0.1837	0.0172
2011	35	0.0893	0.0351	0.0858	0.3935	0.7534	0.1839	0.0179
2012	38	0.0953	0.0386	0.0903	0.4051	1.5942	0.2483	0.0269
2013	45	0.1019	0.0405	0.0980	0.3970	1.4844	0.2623	0.0313
2014	45	0.1167	0.0441	0.1115	0.3777	0.8202	0.2575	0.0375
03—08	133	0.0677	0.0429	0.0667	0.6339	0.7349	0.2423	0.0000
09—14	224	0.1000	0.0405	0.0951	0.4044	1.1592	0.2623	0.0165
Total	357	0.0880	0.0442	0.0878	0.5022	0.7260	0.2623	0.0000
Panel B：Descriptive Statistics of Loss Reserve Ratios								
	Company	Mean	Standard Deviation	Median	CV	Skew	Max	Min
2003	20	0.0530	0.0620	0.0412	1.1692	-0.3235	0.1757	-0.1075
2004	21	0.0658	0.0707	0.0535	1.0740	1.1901	0.2618	-0.0532
2005	24	0.1026	0.1027	0.0798	1.0009	1.7676	0.4428	-0.0497
2006	20	0.0745	0.1212	0.0387	1.6268	2.8366	0.5298	-0.0511
2007	22	0.1318	0.0973	0.1361	0.7387	0.6235	0.3805	-0.0605
2008	26	0.1060	0.0659	0.0871	0.6212	0.9526	0.2615	0.0023
2009	30	0.0724	0.1195	0.0717	1.6498	-1.3176	0.2785	-0.3354
2010	31	0.1431	0.1546	0.1024	1.0808	3.2275	0.8466	-0.0206
2011	35	0.1290	0.2147	0.0827	1.6645	3.6311	1.1916	-0.0940
2012	38	0.0910	0.2376	0.0394	2.6092	4.7743	1.4176	-0.1325
2013	45	0.0721	0.1059	0.0551	1.4689	-0.7055	0.4231	-0.3686
2014	45	0.0704	0.0763	0.0539	1.0830	1.0592	0.2839	-0.0447
03—08	133	0.0906	0.0911	0.0721	1.0054	1.7391	0.5298	-0.1075
09—14	224	0.0883	0.1334	0.0645	1.5102	3.3182	1.1916	-0.3686
Total	357	0.0892	0.1193	0.0678	1.3374	3.1741	1.1916	-0.3686

Panel C：Descriptive Statistics of Adjusted Combined Ratios

	Company	Mean	Standard Deviation	Median	CV	Skew	Max	Min
2003	20	1.6583	0.6960	1.4672	0.4197	1.1565	3.3837	0.8514
2004	21	1.6488	0.6034	1.6374	0.3660	0.477	2.8282	0.8138
2005	24	2.8377	4.7038	1.9742	1.6576	4.4194	24.6689	0.6370
2006	20	2.5481	2.5662	2.0595	1.0071	3.6345	13.0206	0.9876
2007	22	3.2102	2.2535	2.7948	0.7020	2.4555	11.1615	1.1356
2008	26	6.2065	10.2282	2.8522	1.6480	3.2339	43.7097	0.7844
2009	30	2.3230	0.9514	2.0744	0.4095	2.2714	5.7657	1.3308
2010	31	1.8658	0.4805	1.7905	0.2575	0.3253	2.9550	0.7441
2011	35	2.0972	0.8252	1.8118	0.3935	1.9369	5.1010	1.0923
2012	38	2.1341	0.8927	1.9103	0.4183	2.9367	6.1997	1.2270
2013	45	2.1468	0.8765	1.8602	0.4083	2.6864	5.7328	1.3348
2014	45	2.1219	0.7315	1.8503	0.3448	1.9145	4.7675	1.4174
03—08	133	3.1493	5.3065	2.1138	1.6850	5.9590	43.7097	0.6370
09—14	224	2.1013	0.7640	1.8700	0.3636	2.3693	2.3693	0.7441
Total	357	2.4917	3.3262	1.9185	1.3349	9.4569	43.7097	0.6370

APPENDIX

Proof of Proposition 1

(1) According to Table 1, in the pre-NEAC era,

$$UPR_t = PW_t \cdot \theta_t, \quad PE_t = PW_t - (UPR_t - UPR_{t-1}) = PW_t(1-\theta_t) + PW_{t-1}\theta_{t-1},$$

$$CR_t = \frac{PC_t + DLR_t}{PE_t} + \frac{Fc_t + E_t + E_t'}{PW_t},$$

$$\Rightarrow \frac{\partial CR_t}{\partial Fc_t} = \frac{1}{PW_t} > 0,$$

i.e., the combined ratios and the commissions are positively correlated.

(2) In the post-NEAC era,

$$UPR_t = (PW_t - Fc_t - E_t) \cdot \theta_t,$$

$$PE_t = PW_t - (UPR_t - UPR_{t-1})$$

$$= PW_t(1-\theta_t) + (Fc_t + E_t)\theta_t + (PW_{t-1} - Fc_{t-1} - E_{t-1})\theta_{t-1}$$

$$= PW_t(1-\theta_t) + (Fc_t + E_t)\theta_t + (PW_{t-1} - f^{-1}(Fc_t) - E_{t-1})\theta_{t-1}$$

$Fc_t = f(Fc_{t-1})$ is a functional relationship between the commissions of year t and year $t-1$. $Fc_{t-1} = f^{-1}(Fc_t)$ is the inverse function.[18]

$$CR_t = \frac{PC_t + DLR_t + Fc_t + E_t + E_t'}{PE_t} = \frac{C_t}{PE_t},$$

$$\Rightarrow \frac{\partial CR_t}{\partial Fc_t} = \frac{PE_t - C_t[\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}]}{PE_t^2}$$

$$= \frac{1}{PE_t}\left[1 - \frac{C_t}{PE_t} \cdot (\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1})\right]$$

$$= \frac{1}{PE_t}\left[1 - CR_t \cdot (\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1})\right]$$

[18] Many researchers show that combined ratios and loss ratios have an autocorrelation (Venezian 1985; Cummins and Outreville 1987; Doherty and Kang 1988; Harrington and Niehaus 2000; Meier 2006).

$$= \frac{1}{PE_t}\left[1 - CR_t \cdot \frac{1}{\mu_t}\right]$$

where $\mu_t = \dfrac{1}{\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}}$.

Obviously, $PE_t > 0$, $\theta_t \in (0,1)$.

$$\frac{dFc_t}{dFc_{t-1}} = f'(Fc_{t-1}) < 0 \text{ [19]} \Rightarrow (f^{-1}(Fc_t))' = \frac{1}{f'(Fc_{t-1})} < 0$$

So $0 < \mu_t = \dfrac{1}{\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}} < \dfrac{1}{\theta_t}$.

Therefore,

when $CR_t < \mu_t$, $\dfrac{\partial CR_t}{\partial Fc_t} > 0$, CR_t is monotonically increasing with Fc_t, i.e., the higher the fees and commissions, the higher the combined ratio;

when $CR_t > \mu_t$, $\dfrac{\partial CR_t}{\partial Fc_t} < 0$, CR_t is monotonically decreasing with Fc_t, i.e., the higher the commissions, the lower the combined ratio;

and when $Fc_t \to +\infty$, $CR_t \to \mu_t = \dfrac{1}{\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}}$.

[19] In general, if PC insurance companies prepay ΔFc more commissions to intermediaries in year *t*-1, then ΔFc will be saved in year *t*. So, Fc_t and Fc_{t-1} are negatively correlated, i.e., $\dfrac{dFc_t}{dFc_{t-1}} < 0$.

Proof of Proposition 2

(1) In the pre-NEAC era,

$$ER_t = \frac{Fc_t + E_t + E_t'}{PW_t},$$

$$\Rightarrow \frac{\partial ER_t}{\partial Fc_t} = \frac{1}{PW_t} > 0$$

i.e., the expense ratios and commissions are positively correlated.

(2) In the post-NEAC era,

$$ER_t = \frac{Fc_t + E_t + E_t'}{PE_t},$$

$$\Rightarrow \frac{\partial ER_t}{\partial Fc_t} = \frac{PE_t - (Fc_t + E_t + E_t')[\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}]}{PE_t^2}$$

$$= \frac{1}{PE_t}\left[1 - \frac{Fc_t + E_t + E_t'}{PE_t} \cdot (\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1})\right]$$

$$= \frac{1}{PE_t}\left[1 - ER_t \cdot \frac{1}{\mu_t}\right]$$

where $\mu_t = \frac{1}{\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}}$.

Therefore,

when $ER_t < \mu_t$, $\frac{\partial ER_t}{\partial Fc_t} > 0$, ER_t is monotonically increasing with Fc_t, i.e., the higher the fees and commissions, the higher the expense ratio;

when $ER_t > \mu_t$, $\frac{\partial ER_t}{\partial Fc_t} < 0$, ER_t is monotonically decreasing with Fc_t, i.e., the higher the commissions, the lower the expense ratio;

and when $Fc_t \to +\infty, ER_t \to \mu_t$.

Proof of Proposition 3

According to Table 1, in the pre-NEAC era,

$$Profit_t = PE_t - C_t$$

$$= PW_t(1-\theta_t) + PW_{t-1}\cdot\theta_{t-1} - \left(PC_t + DLR_t + Fc_t + E_t + E_t'\right)$$

$$\frac{\partial Profit_t}{\partial Fc_t} = -1 < 0.$$

In the post-NEAC era,

$$Profit_t = PE_t - C_t$$

$$= PW_t(1-\theta_t) + (Fc_t + E_t)\theta_t + (PW_{t-1} - f^{-1}(Fc_t) - E_{t-1})\theta_{t-1} - \left(PC_t + DLR_t + Fc_t + E_t + E_t'\right)$$

$$\frac{\partial Profit_t}{\partial Fc_t} = -\left(1 - \frac{1}{\mu_t}\right).$$

As in Proposition 1, we have proven that $0 < \mu_t < \frac{1}{\theta_t}$, so $1 - \frac{1}{\mu_t} < 1$;

i.e., in the post-NEAC era, profits and commissions are still negatively and linearly correlated, but the sensitivity between them is decreased.

Proof of Proposition 4

According to Table 1, in the pre-NEAC era,

$$CR_t = \frac{PC_t + DLR_t}{PE_t} + \frac{Fc_t + E_t + E_t'}{PW_t}$$

$$\Rightarrow \frac{\partial CR_t}{\partial DLR_t} = \frac{1}{PE_t}.$$

In the post-NEAC era,

$$CR_t = \frac{PC_t + DLR_t + Fc_t + E_t + E_t'}{PE_t}$$

$$\Rightarrow \frac{\partial CR_t}{\partial DLR_t} = \frac{1}{PE_t}$$

Therefore, in both the pre- and the post-NEAC eras, loss reserves and combined ratios are positively and linearly correlated. However, in the post-NEAC era, the premiums earned, PE_t, increases, i.e., the sensitivity of the combined ratios to loss reserves decreases, due to the initial expenses such as commissions.

It is worth noting that premiums written and premiums earned are not affected by the DLR. Premiums earned is only affected by the UPR, and premiums written is not affected by any other items.

Proof of Proposition 5

(1) According to Table 1, in the pre-NEAC era,

$$APE_t = PW_t - UPR_t = PW_t(1-\theta_t), \quad ACR_t = \frac{PC_t + DLR_t}{APE_t} + \frac{Fc_t + E_t + E_t'}{PW_t},$$

$$\Rightarrow \frac{\partial ACR_t}{\partial Fc_t} = \frac{1}{PW_t} > 0,$$

i.e., the adjusted combined ratios and commissions are positively and linearly correlated.

(2) In the post-NEAC era,

$$APE_t = PW_t - UPR_t = PW_t(1-\theta_t) + (Fc_t + E_t)\theta_t,$$

$$ACR_t = \frac{PC_t + DLR_t + Fc_t + E_t + E_t'}{APE_t} = \frac{C_t}{APE_t},$$

$$\Rightarrow \frac{\partial ACR_t}{\partial Fc_t} = \frac{APE_t - C_t \cdot \theta_t}{APE_t^2} = \frac{1}{APE_t}\left(1 - \frac{C_t}{APE_t} \cdot \theta_t\right) = \frac{1}{APE_t}\left(1 - ACR_t \cdot \theta_t\right)$$

Obviously, $APE_t > 0$, $\theta_t \in (0,1)$, so

when $ACR_t < \frac{1}{\theta_t}, \frac{\partial ACR_t}{\partial Fc_t} > 0$, ACR_t is monotonically increasing with Fc_t, i.e., the higher the commissions, the higher the combined ratio;

when $ACR_t > \frac{1}{\theta_t}, \frac{\partial ACR_t}{\partial Fc_t} < 0$, ACR_t is monotonically decreasing with Fc_t, i.e., the higher the commissions, the lower the combined ratio;

and when $Fc_t \to +\infty, ACR_t \to \frac{1}{\theta_t}$.

(3) According to Table 1, in the post-NEAC era,

$$\frac{1}{CR_t} = \frac{1}{ACR_t} + \frac{UPR_{t-1}}{C_t} = \frac{1}{ACR_t} + \frac{(PW_{t-1} - Fc_{t-1} - E_t) \cdot \theta_{t-1}}{PC_t + DLR_t + Fc_t + E_t + E_t'}$$

$$\Rightarrow \lim_{Fc_t \to +\infty} \frac{1}{CR_t} = \lim_{Fc_t \to +\infty} \left[\frac{1}{ACR_t} + \frac{(PW_{t-1} - Fc_{t-1} - E_t) \cdot \theta_{t-1}}{PC_t + DLR_t + Fc_t + E_t + E_t'} \right].$$

As has been proven, when $Fc_t \to +\infty$, $ACR_t \to \frac{1}{\theta_t}$,

i.e., $$\lim_{Fc_t \to +\infty} \frac{1}{ACR_t} = \theta_t \qquad \text{(i)}$$

and $\frac{dFc_t}{dFc_{t-1}} < 0$, when $Fc_t \to +\infty$, $Fc_{t-1} = f^{-1}(Fc_t) \to -\infty$.

According to L'Hospital's rule,

$$\Rightarrow \lim_{Fc_t \to +\infty} \frac{(PW_{t-1} - Fc_{t-1} - E_t) \cdot \theta_{t-1}}{PC_t + DLR_t + Fc_t + E_t + E_t'} = \lim_{Fc_t \to +\infty} \frac{(PW_{t-1} - f^{-1}(Fc_t) - E_t) \cdot \theta_{t-1}}{PC_t + DLR_t + Fc_t + E_t + E_t'}$$

$$= \lim_{Fc_t \to +\infty} \left[-(f^{-1}(Fc_t))' \cdot \theta_{t-1} \right] \qquad \text{(ii)}$$

According to (i) and (ii), we can see that when $Fc_t \to +\infty$,

$$\frac{1}{CR_t} \to \theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}$$

i.e., $$CR_t \to \frac{1}{\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}} = \mu_t \qquad \text{(iii)}$$

Therefore, according to (i) and (iii), when $ACR_t \to \frac{1}{\theta_t}$, $CR_t \to \mu_t$,

i.e., the threshold of the adjusted combined ratio $\frac{1}{\theta_t}$ and that of the combined ratio μ_t have a one-to-one correspondence.

Proof of Proposition 6

Assume that the premium growth rate is λ_t, i.e., $PW_t = (1+\lambda_t)PW_{t-1}$

$$APE_t = \frac{1}{2}PW_t, \quad UPR_t = \frac{1}{2}PW_t$$

$$CR_t = \frac{C_t}{PE_t} = \frac{C_t}{PW_t - UPR_t + UPR_{t-1}} = \frac{C_t}{\frac{1}{2}PW_t + \frac{1}{2}PW_{t-1}}$$

$$= \frac{C_t}{\frac{1}{2}PW_t \cdot \left(1 + \frac{1}{1+\lambda_t}\right)} = \left(\frac{1+\lambda_t}{2+\lambda_t}\right)\frac{C_t}{\frac{1}{2}PW_t}$$

$$= \left(\frac{1+\lambda_t}{2+\lambda_t}\right)\frac{C_t}{APE_t} = \left(\frac{1+\lambda_t}{2+\lambda_t}\right)ACR_t$$

When $\lambda_t = 6.91\%$ and $ACR_t = \frac{1}{\theta_t} = 2$, $CR_t = \mu_t = 1.03$.

Proof of Proposition 7

We denote the adjusted combined ratios in the pre- and post-NEAC eras as ACR_t^{old} and ACR_t^{new}, respectively, and α_t is the proportion of initial expenses to premiums written.

$$ACR_t^{old} = \frac{C_t}{APE_t^{old}} = \frac{C_t}{(1-\theta_t)PW_t},$$

$$ACR_t^{new} = \frac{C_t}{APE_t^{new}} = \frac{C_t}{PW_t - (PW_t - \alpha_t PW_t)\theta_t}.$$

When $ACR_t^{new} = \frac{1}{\theta_t}$, we have $\frac{C_t}{PW_t} = \frac{1-(1-\alpha_t)\theta_t}{\theta_t}$.

Therefore, $ACR_t^{old} = \frac{1}{\theta_t} + \frac{\alpha_t}{1-\theta_t}$.

Proof of Proposition 8

If NISR had not been implemented, then

$$CR_t = \frac{PC_t + DLR_t}{PE_t} + \frac{Fc_t + E_t + E_t'}{PW_t}$$

In the pre-NEAC era, $PE_t = PW_t - (UPR_t - UPR_{t-1})$, $UPR_t = PW_t \cdot \theta_t$

then, $\frac{\partial CR_t}{\partial Fc_t} = \frac{1}{PW_t}$

In the post-NEAC era, $PE_t = PW_t - (UPR_t - UPR_{t-1})$,

$UPR_t = [PW_t - (Fc_t + E_t)] \cdot \theta_t + RM_t$

then $\frac{\partial CR_t}{\partial Fc_t} = -\frac{PC_t + DLR_t}{PE_t^2}\left(\theta_t - (f^{-1}(Fc_t))' \cdot \theta_{t-1}\right) + \frac{1}{PW_t}$

$$= -\frac{LR_t}{PE_t \cdot \mu_t} + \frac{1}{PW_t},$$

where $LR_t = \frac{PC_t + DLR_t}{PE_t}$, i.e., Loss Ratio

Obviously, even if we do not change NISR, in the post-NEAC era,

when $LR_t < \frac{PE_t}{PW_t} \cdot \mu_t$, $\frac{\partial CR_t}{\partial Fc_t} > 0$, CR_t is monotonically increasing with Fc_t,

i.e., the higher the fees and commissions, the higher the combined ratio;

when $LR_t > \frac{PE_t}{PW_t} \cdot \mu_t$, $\frac{\partial CR_t}{\partial Fc_t} < 0$, CR_t is monotonically decreasing with Fc_t,

i.e., the higher the commissions are, the lower the combined ratio is.

Proof of Proposition 9

If NEAC had not been implemented, then

$PE_t = PW_t - \left(UPR_t - UPR_{t-1}\right)$, $UPR_t = PW_t \cdot \theta_t$

In the pre-NISR era, $CR_t = \frac{PC_t + DLR_t}{PE_t} + \frac{Fc_t + E_t + E_t'}{PW_t}$

then $\frac{\partial CR_t}{\partial Fc_t} = \frac{1}{PW_t}$

In the post-NISR era, $CR_t = \frac{PC_t + DLR_t + Fc_t + E_t + E'}{PE_t}$

then, $\frac{\partial CR_t}{\partial Fc_t} = \frac{1}{PE_t}$

Obviously, $\frac{1}{PE_t} > \frac{1}{PW_t}$

Therefore, if NEAC had not been implemented (in either the pre- or the post-NISR era), then the commissions and the combined ratios would be linearly and positively correlated. However, in the post-NISR era, the combined ratios would be more sensitive to commissions.